ern division received an average of about four inches, the middle division nearly three and a half inches, and the western division two and a half inches. The greatest precipitation for the month was 5.93 inches, reported at Hohenwald, and the least was 1.48 inches, reported at Nashville. The greatest local daily rainfall was 3.04 inches reported at Hohenwald on the 13th. The next greatest amounts were reported at Jonesborough and Greeneville on the 4–5th, and these were of melted snow. The day of the greatest rainfall was the 17th, the corresponding date of the greatest daily rainfall of the month previous. Most of the rains during the month were comparatively light and many of them were general. The 7th, 8th, 9th, 10th, 19th, 20th, were reported without precipitation.

The feature of the month, as above stated, was the great fall of snow which occurred on the 3d, 4th, and 5th. This was the greatest snowfall that, perhaps, occurred in December for many years, and was very heavy in the eastern division, reaching a depth of 36 inches in the extreme eastern portion. In many places the roofs of houses and barns were crushed by the weight of the snow, and travel was almost suspended. In the southern portion of the middle division the depth was much greater than in the northern portion. It was also great in some portions of the western division. Considerable snow also fell on the 15th throughout the state, and this was in many places attended with high winds which caused it to drift greatly. Some snow also fell on the latter days of the month.

Summary.

Mean temperature, 34°.6; highest temperature, 73°, on the 11th, at Beach Grove; lowest temperature, —8°, on the 7th, at Farmingdale; range of temperature, 81°; mean monthly range of temperature; 55°.8; greatest monthly range of temperature, 69°, at Beach Grove; least monthly range of temperature, 44°, at Dyersburg; mean daily range of temperature, 14°.7; greatest daily range of temperature, 46°, on the 7th, at Fostoria; least daily range of temperature, 2°, on the 27th, at Hurricane Switch, Waverly, Dickson, and Trenton, and on the 28th at Florence Station and Nashville; mean of maximum temperatures, 60°.7; mean of minimum temperatures, 4°.8.

Average number of clear days, 9.7; average number of fair days, 8; average number of cloudy days, 13.3; average number of days on which rain or snow fell, 9.8.

Mean depth of rainfall, 3.36 inches; mean daily rainfall, 0.108 inch; greatest rainfall, 5.93 inches, at Hohenwald; least rainfall, 1.48 inches, at Nashville; greatest local daily rainfall, 3.04 inches, on the 13th, at Hohenwald; days of greatest rainfall, 4th, 15th, 17th, 24th, 28th, 29th, 31st; day of greatest rainfall, 17th; days without rainfall, 2d, 7th, 8th, 9th, 10th, 19th, 20th; mean depth of snowfall, 13.1 inches.

Warmest days, 11th, 23d; coldest days, 7th, 16th.

Prevailing winds, north and northwest.

NOTES AND EXTRACTS.

The question of the temperature relations in the upper air strata during thunder-storms is of so great importance that the following translation of a discussion upon that question has been made by the thunder-storm division. A few notes are appended:

Hazen ?

DIPPING OF THE FREEZING-POINT PLANE BEFORE THUNDER-STORMS, BY KARL PROHASKA IN GRAZ.

[Translated from "Das Wetter" of September, 1886.]

Among the lately published theories in relation to the origin of thunder-storm electricity that of Professor Sohncke demands special attention, as well by reason of the completeness of the treatment, as on account of his simple and consistent principle of explaining the cause of the appearances in question. Sohncke sees in the friction of water drops on the particles of ice floating in the atmosphere the cause of electric meteors. From the fact that during thunder-storms cirrus clouds are always to be seen, he makes the deduction that water and snow clouds are there present simultaneously—the first always below, the second generally above, the "freezing-point plane." By ascending currents or greater atmospheric whirls the water particles, when the cirrus clouds are low, can be carried into the region of the ice particles, and in the friction between the particles of the ice and water clouds we would have to seek, according to Sohncke, the origin of thunder-storm and atmospheric electricity.

An essential part of Sohncke's proof rests upon the assumption that the stratum of cirrus clouds at the time of thunder-storms is very low so that contact of the cumuli with the ice particles becomes possible. Sohncke refers to the observations of æronauts to show that the "freezing-point plane" is especially low before the outbreak of a thunder-storm. The observations of æronauts bearing on this question by no means reach a positive proof. Sohncke investigated, therefore, the temperature difference due to the difference in height (719 m.) of the stations Freiburg and Höchenschwand in Baden. His investigations confirmed his supposition that on thunder-storm days the temperature almost always decreases faster from below upward than at other times; for of seventeen cases considered, in which these stations furnished simultaneous thunder-storms, there were only three in which the difference of temperature was below the normal, while in all other cases it was above normal. Also Kaemtz established in his meteorology that a rapid alteration of temperature with height is an important condition in the formation of summer thunder-storms.

Dr. Assmann in his work on thunder-storms in Germany endorses Sohncke's hypothesis. He compared the temperature observations at the stations Salzungen (253 m.), Eisenach (240 m.), and Erfurt (196 m.), with those at Inselberg (906 m.), and found that out of sixty-four days on which thunder-storms occurred simultaneously at the four stations, forty-six, or 72 per cent., had a difference above the normal, fixed by Dr. Hann at 0°.6 to 0°.7 C. for 100 meters in summer.

On the other hand, a comparison instituted by Assmann of the observations at the stations Schneekoppe and Eichberg, furnish negative results in a decision of this question. Professor Hann also expressed himself at the second meeting of the German Meteorological Society in 1885, to the effect that he considered the dipping of the "freezing-point plane" before the outbreak of a thunder-storm as improbable. In the annual report of the Royal Institution of Meteorology and Terrestrial Magnetism at Vienna have been published since 1881 the observations, in detail, at a large number of Austrian stations, among them the high stations Obirgipfel and Schafberg. In order to furnish a contribution, aiding in the decision of this question, I compared the temperature observations at the stations Schafberg (1,776 m.) with those at Salzburg (436 m.) and Kremsmünster (384 m.), and the observations at Obirgipfel (2,044 m.) with those at Klagenfurt (438 m.) and Laibach (287 m.). The data from Salzburg, Kremsmünster, and Laibach, I took likewise from the annual report. The detailed observations for Klagenfurt have been published regularly since 1867 in the annual report of the Natural History Land Museum of Kärnten. I used the material of the four years 1881–1884, and restricted myself to the four months May–August, because in the remaining months there were few simultaneous storms recorded at the low stations and their corresponding high stations.

In the first group above, only those cases, in general, were considered in which thunder-storms were recorded at the three stations, Schafberg, Salzburg, and Kremsmünster, at almost the same time of day, but in some months thunder-storm notes were wanting. I could then depend only on the data from Salzburg and Kremsmünster, and took each day into consideration on which these two stations furnished heavy thunder-storms, and Schafberg great precipitation.

In the second group above there were during the years 1881–1884 relatively few days on which simultaneous thunder-storms occurred at all three stations. I had, therefore, to consider the cases for both valley stations separately. The difference of temperature on thunder-storm days was now taken out for that one of the three daily observations (7 a. m., 2 p. m., 9 p. m.) which was nearest to the outbreak of the storm. In cases where it was difficult to decide this, I gave the preference to the observation hour preceding the storm, because I had to assume that the differences in temperature were largely influenced by the intensity and character of the rainfall, and by other attendant appearances (as a rapid increase in temperature), and did not belong so much to the condition during the formation of the storm.

In order now to decide whether in a special case the differences in temperature were above or below the normal, the mean monthly differences, reckoned from that observation which was nearest the beginning of the storm, were taken out as the normal. In determining whether the difference of temperature in the case of a storm in May, 4–6 p. m., was abnormal or not, the four year mean difference for May, 2 p. m., was taken as the normal, and the departure from that was reckoned. The differences of the mean temperature in the months May–August for the years 1881–1884, are shown in the following table, arranged according to the tri-daily observations:

Mean temperature (Centigrade) differences, 1881–1884.

Month.	(1) Salzburg and Schafberg.			(2) Kremsmünster and Schafberg.			(3) Klagenfurt and Obirgipfel.			(4) Laibach and Obirgipfel.		
	7 a. m.	2 p. m.	9 p. m.	7 a. m.	2 p. m.	9 p. m.	7 a. m.	2 p. m.	9 p. m.	7 a. m.	2 p. m.	9 p. m.
	°	°	°	°	°	°	°	°	°	°	°	°
May	6.5	10.7	8.3	6.7	10.4	8.4	10.1	13.8	11.4	10.3	14.0	11.3
June	7.7	10.7	8.7	7.5	10.2	8.4	10.9	13.4	11.2	10.1	13.7	11.1
July	7.1	10.5	8.4	6.9	10.3	8.6	9.4	12.3	10.2	8.9	13.1	10.7
August	6.5	10 3	7.6	6.2	9.4	7.7	8.1	11.4	9.7	7.9	11.8	9.7
Mean	7.0	10.5	8.2	6.8	10.1	8.3	9.6	12.7	10.6	9.3	13.1	10.7
Mean of all	....	8.6	....	....	8.4	....	....	11.0	....	....	11.0	....

From this table it appears quite plainly that the normal difference in temperature beginning with May, or at least with June, continually decreases till August. This is specially evident in the differences of Laibach-Obirgipfel. In group three, the great difference in June, 7 a. m., is surprising, but may be traced to the fact that at the station Klagenfurt the thermometer during the morning hours was not wholly shielded at the time of the greatest yearly altitude of the sun from radiation influence, which was specially noticeable in the years 1875–1880.

To the *yearly* period of temperature difference there is a corresponding *daily* period, in which the maximum is sharply defined at 2 p. m. I thought therefore in the preceding case, that the numbers, which were calculated by Dr. Hann, for the separate months in reckoning the temperature difference with height, would not apply, although the computation would have been simpler, because I held that, on account of the great daily change, it was necessary to consider the time of the thunder-storm as nearly as was possible with the three daily observations. If we take Dr. Haun's value for the fall in temperature with height from May–August, and reckon the amount for the difference of 1,340 and 1,757 metres we shall find in the first case 8°.7, and in the second case 11°.4, which agree well with the observed values 8°.6 and 11°.0, so that the result for the mean compares well.

The investigation has now shown that in the group Schafberg-Salzburg, for forty-two cases, sixteen had a temperature difference above the normal, and twenty-six below; but in the average of these forty-two cases the difference remained 0°.46 below the normal. In the group Schafberg-Kremsmünster there were forty-two cases; in twenty-six the difference in temperature was above normal, and in twenty-two below it. In the mean it remained 0°.19 too great. In the group Obirgipfel-Klagenfurt, sixty instances were considered. In thirty the difference was above and in thirty below the normal. In the mean of the sixty cases it was 0°.36 less than the normal. Finally, in the group Obirgipfel-Laibach, there were fifty-one cases, the difference in twenty-six of these being greater, in twenty-five less than normal. From the whole one hundred and ninety-five days on which the difference in temperature was compared with the normal, only ninety-two showed a positive and one hundred and three a negative departure, which gave as the mean of all —0°.1.

The result of the investigation is, therefore, not at all favorable to Sohncke's theory, and the majority of cases even makes against it. The comparison of the high stations with the stations Salzburg and Klagenfurt shows that the temperature difference on thunder-storm days is, on the average, 0°.4 (3–5 per cent.) less than the normal. For the stations Kremsmünster and Laibach, on the other hand, the comparison with the corresponding high stations shows a difference of 0°.2 above the normal. The explanation of this contradictory relation of the low stations Salzburg and Klagenfurt, on the one hand, and Kremsmünster and Laibach on the other, is dependent, in my opinion, on the geographical position of the low stations relative to the high. Salzburg and Klagenfurt lie to the west and northwest, Kremsmünster and Laibach to the east and south of their high stations, and because the thunder-storms in the Austrian North Alps come generally from the west, and in the South Alps from the west and northwest, the stations Salzburg and Klagenfurt get the oncoming storms, as a rule, earlier, but Kremsmünster and Laibach later than their high stations. The accompanying reduction in temperature will advance from the west and northwest toward the east and southeast, and therefore, the temperature difference in the case of the stations lying to west and northwest will be too small, and in the case of those to the east and south, too great.

The horizontal distance of low stations from their high stations involves a certain difference in the time of beginning of the storm, and thus this method of investigation furnishes a fruitful source of error, which becomes greater as the distance between the high and low station increases. For this reason we must give the greatest weight to the group, Obirgipfel-Klagenfurt, where the horizontal distance is scarcely 20 km. But the comparison of these stations gives a result opposed to the assumption of a dipping of the "freezing-point plane" before thunder-storms.

Hourly detailed observations or temperature curves from registering apparatus at stations having a significant difference in altitude, and horizontally near each other, would furnish a more accurate method of investigation. But this much appears to have resulted with certainty from this investigation, viz., that if in general a dipping of the "freezing-point plane" does occur before thunder-storms, it makes itself sensible only shortly before the outbreak of the storm (perhaps even as an effect of the storm, not in any way a cause aiding its formation), and only to a slight degree.

NOTE.

The negative result determined in the above discussion is quite satisfactory as regards temperature changes in the upper strata up to an height of 2,044 metres (6,706 feet). It also seems probable that that height is sufficient to show any marked effects in the case of most storms, as Professor Loomis has proved that a large majority of our storms are developed below the summit of Mount Washington, but it may be held that the conditions may be very different at heights much greater. It would be interesting to compare the observations at the base and summit of the two isolated high stations in this country; Mount Washington in the East (6,279 feet), and Pike's Peak (14,134 feet) in the West. The first has Burlington, Vermont, near sea-level, and the second Colorado Springs, which is about 8,000 feet below the summit. It would seem that the most satisfactory discussion would be of the records at the time of quite heavy rain. All the observations of pressure and temperature during the occurrence of marked rainfall in the summer months of 1873 and 1874 at Mount Washington, and the same for Pike's Peak in 1874, were used in the following tables. Each figure in these tables represents the mean of ten observations. The observations were taken at nearly equal intervals three times each day. The morning observation nearest to the time of the rainfall was taken as the central observation, and seven days records before and after were used. In order to eliminate the diurnal range from the temperature, the difference between the monthly mean for each hour and the mean of all the hours was applied to each observation, *e. g.*, at the morning observation it was always necessary to add a small quantity. This is essentially the method of procedure suggested in the "American Meteorological Journal" for August, 1886.

If the figures in this table be plotted the following facts will be noted:

(1) The pressure steadily falls for about two days before the centre passes, and rises as steadily for two days after.

(2) It falls and rises nearly the same amount at the base and summit of Mount Washington, but not quite as much at Pike's Peak as at its base.

(3) The diurnal range is very marked at Colorado Springs and Pike's Peak and in opposite directions, as was to be expected.

(4) The temperature fluctuations were not very marked, but were nearly the same at summit and base; they show a rather uniform increase on the approach of the centre and a sharp fall immediately after it has passed.

(5) The diurnal range has not been quite eliminated but shows, in general, the singular fact that while it is over compensated five to seven days before the centre, it is under compensated two or three days before. This seems to indicate an increased insolation as the centre approaches which causes the p. m. temperature to read relatively much higher near the centre than away from it.

(6) The increase as the rainfall approaches is very slight amounting to about 4° in forty-eight hours; if we regard the velocity of the advancing rain as twenty miles per hour this increase in temperature at the height of Mount Washington would give a gradient of one foot in 100,000, which is inappreciable.

A similar computation for Geneva and Great Saint Bernard indicated the same conditions as above for pressure but much smaller changes in temperature. The latter, instead of rising as the rainfall approached, really reached its maximum, 1°.5, to 2 days before the centre, then fell sharply to about sixteen hours before the centre, when it reached the normal and continued. It will be noted that these facts corroborate the investigation of Professor Prohaska, and indicate that as we ascend in the atmosphere there are no marked fluctuations in temperature on the approach of summer storms. A similar investigation has shown the same for winter storms.

Pressure and temperature at the base and summit of Mount Washington and Pike's Peak during marked summer rainfall.

[Mean of ten rains in each column.]

	Summer of 1873.				Summer of 1874.				Summer of 1874.			
	Pressure.		Temperature.		Pressure.		Temperature.		Pressure.		Temperature.	
	Mount Washington.	Burlington.	Mount Washington.	Burlington.	Mount Washington.	Burlington.	Mount Washington.	Burlington.	Pike's Peak.	Colorado Springs.	Pike's Peak.	Colorado Springs.
	Inches	Inches	°	°	Inches	Inches	°	°	Inches	Inches	°	°
7 days before	23.85	30.03	43.7	67.9	23.66	29.88	38.1	59.0	17.99	24.17	35.5	68.1
	23.87	29.99	42.5	64.4	23.68	29.88	35.6	56.7	18.01	24.12	36.6	68.0
	23.88	30.05	43.5	64.9	23.72	29.93	36.0	58.3	18.02	24.16	36.7	69.1
6 days before	23.87	30.09	42.4	65.6	23.72	29.91	37.4	59.1	18.01	24.17	37.8	68.9
	23.88	30.01	41.9	66.6	23.82	29.97	38.2	57.8	18.02	24.11	36.3	68.2
	23.88	30.06	42.8	67.4	23.82	29.96	39.2	59.7	18.03	24.15	37.7	69.5
5 days before	23.89	30.11	42.7	66.8	23.80	29.99	39.3	60.1	18.02	24.17	38.8	69.6
	23.92	30.06	42.0	66.4	23.76	29.88	39.9	60.6	18.03	24.12	34.9	67.4
	23.94	30.08	42.8	65.7	23.71	29.88	39.8	60.6	18.04	24.18	36.6	69.0
4 days before	23.93	30.06	44.2	69.0	23.69	29.93	38.9	58.9	18.03	24.22	36.8	67.4
	23.90	29.96	45.5	70.0	23.69	29.88	38.2	59.5	18.06	24.17	35.6	67.0
	23.91	30.02	45.5	71.0	23.73	29.91	38.4	60.8	18.07	24.21	36.5	68.0
3 days before	23.92	30.09	45.1	69.6	23.74	29.97	39.1	60.4	18.07	24.22	38.1	69.5
	23.91	30.04	44.3	66.8	23.77	29.91	39.6	59.5	18.08	24.17	36.8	71.9
	23.90	30.06	43.1	66.6	23.79	29.97	40.0	58.6	18.08	24.20	38.3	70.0
2 days before	23.88	30.12	43.6	67.2	23.85	30.07	39.5	59.0	18.05	24.19	39.1	69.9
	23.88	30.01	42.5	65.9	23.84	29.99	40.1	63.8	18.06	24.12	38.5	72.9
	23.84	30.02	44.5	65.2	23.85	29.97	39.7	63.1	18.05	24.14	39.6	73.0
1 day before	23.85	29.98	46.0	66.7	23.80	29.91	42.1	63.5	18.02	24.15	39.9	73.2
	23.78	29.81	48.0	68.4	23.71	29.73	42.7	61.1	18.02	24.08	39.0	73.0
	23.76	29.81	47.6	71.6	23.64	29.71	43.0	64.2	17.99	24.10	38.7	71.7
Centre	23.71	29.77	47.2	72.0	23.61	29.71	42.6	63.3	17.97	24.09	38.9	74.2
	23.70	29.79	45.2	62.7	23.59	29.70	38.9	58.9	17.99	24.04	36.4	69.4
	23.71	29.90	43.1	64.0	23.60	29.77	38.2	62.2	17.99	24.11	37.6	69.5
1 day after	23.76	29.98	40.5	64.9	23.65	29.91	36.7	57.3	17.99	24.16	36.8	70.1
	23.85	29.99	40.1	65.1	23.72	29.92	37.4	58.4	18.02	24.14	36.8	63.6
	23.90	30.07	40.7	62.4	23.76	29.97	38.5	58.3	18.03	24.19	36.9	66.5
2 days after	23.94	30.12	41.9	65.5	23.81	30.09	36.8	60.5	18.02	24.20	37.2	69.5
	23.92	30.03	41.7	64.3	23.88	30.06	38.5	62.1	18.04	24.15	37.7	67.4
	23.90	30.04	43.1	66.4	23.91	30.08	38.3	61.5	18.05	24.19	37.8	67.5
3 days after	23.88	30.04	44.0	68.5	23.94	30.14	41.8	61.3	18.04	24.20	37.1	69.8
	23.89	30.00	43.3	65.6	23.95	30.04	43.1	62.0	18.04	24.13	37.3	68.5
	23.89	30.06	43.4	65.7	23.92	30.01	43.5	63.9	18.03	24.17	37.9	69.8
4 days after	23.89	30.08	44.2	68.3	23.86	29.97	45.5	64.4	18.00	24.15	37.1	69.4
	23.90	30.00	44.6	67.4	23.80	29.86	43.4	63.3	18.01	24.13	36.9	66.0
	23.91	30.02	45.2	68.9	23.76	29.86	43.5	64.9	18.02	24.17	36.9	67.3
5 days after	23.90	30.03	45.5	68.4	23.72	29.90	41.6	64.1	18.01	24.18	36.4	68.2
	23.87	29.94	46.6	68.4	23.71	29.86	39.6	59.1	18.03	24.14	35.8	66.9
	23.84	29.95	46.2	69.9	23.73	29.88	40.2	60.9	18.04	24.20	35.8	66.5
6 days after	23.83	29.94	45.0	70.6	23.77	29.96	40.4	62.5	18.03	24.20	35.8	68.9
	23.79	29.87	43.8	66.4	23.78	29.90	41.4	62.3	18.04	24.15	36.9	70.0
	23.77	29.93	44.0	66.2	23.80	29.93	40.7	63.5	18.04	24.20	37.1	69.2
	23.75	29.97	41.2	67.2	23.79	30.01	40.4	63.1	18.03	24.21	37.3	70.7

METEOROLOGICAL SUMMARY FOR THE YEAR 1886.

[Prepared by Prof. F. H. Snow, of the University of Kansas, from observations taken at Lawrence.]

The year 1886 was marked by an excessively cold January, a long, hot summer, a dry atmosphere, light winds, and clear skies. But the most remarkable characteristic of the year was the very light rainfall of its second half. Up to the 1st of July the rainfall was only 1.79 inches below the average, but for the remainder of the year there was a deficiency of 9.23 inches, the total precipitation being less than half the normal amount. Although the total rainfall was much less than any previous year of our record, the copious rains of the first six months secured good crops of wheat and half crops of corn in the districts most seriously affected by the drought.

Temperature.—Mean temperature of the year, 52°.96, which is 0°.04 above the mean of the eighteen preceding years. The highest temperature was 105° on August 16th; the lowest was 18° below zero on the 9th of January, giving a range of 123°. Mean, at 7 a. m., 47°.13; at 2 p. m., 62°.16; at 9 p. m., 51°.28.

Mean temperature of the winter months, 23°.33, which is 5°.88 below the average winter temperature; of the spring, 54°.57, which is 0°.96 above the average; of the summer, 76°.80, which is 0°.96 above the average; of the autumn, 57°.17, which is 3°.39 above the average.

The warmest month of the year was July, with mean temperature 79°.54; the warmest week was August 11th to 17th, mean 86°.93; the warmest day was August 16th, mean 90°.62. The mercury reached or exceeded 90° on fifty-three days, thirteen more than the average number, viz.: two in May, three in June, twenty-one in July, eighteen in August, and nine in September. There were five days on which the temperature exceeded 100°—one in July and four in August.

The coldest month was January, with mean temperature 14°.32; the coldest week was January 6th to 12th, mean temperature 0°.61 below zero; the coldest day was January 8th, mean 12°.75 below zero. The mercury fell below zero on sixteen days, of which ten were in January, three in February, and three in December.

The last hoar frost of spring was on April 27th; the first hoar frost of autumn was on October 1st; giving an interval of one hundred and fifty-five days, or over five months, entirely without frost. This is precisely the average interval.

The last severe frost of spring was on April 5th; the first severe frost of autumn was on the 27th of October; giving an interval of two hundred and three days, or nearly seven months, without severe frost. The average interval is one hundred and ninety-eight days. No frosts during spring and autumn caused damage to crops of grain and fruit, but the low temperatures of January were universally destructive to peach buds.

Rain.—The entire rainfall, including melted snow, was 24.25 inches, which is 11.02 inches below the annual average. Either rain or snow, or both, in measurable quantities, fell on one hundred and three days—one less than the average. On fifteen other days rain or snow fell in quantity too small for measurement.

The number of thunder-showers was twenty-eight. There was but one light hail storm during the year.

The drought which prevailed during July, August, and September, was the only serious drought in Kansas since 1874. From June 26th to July 24th, an interval of twenty-seven days, there was entire absence of rain. From the same date to September 16th, a period of eighty-one days, the rainfall was but 2.85 inches. In 1874 the drought extended from June 14th to September 3d, an interval of eighty days, during which the rainfall was only 2.19 inches. Thus the drought of 1886 was one day longer than that of 1874, but the latter began nearly two weeks earlier in the season and was, therefore, more disastrous in its effects.

FREQUENCY OF LIGHTNING STROKES.

[From Beiträge zur Statistick der Blitzschläge in Deutchland, von Dr. Hellmann, Berlin, 1886; Zeit. d. König. Preuss. Stat. Bureau, 1886. Translated by ALEX. MCADIE, Sergeant, Signal Corps, U. S. Army.]

A summary of the results of the investigation on the frequency of lightning strokes in Germany appears as one of the reports of the Royal Prussian Bureau of Statistics. As it deals directly with risk of damage to buildings from lightning the main conclusions of the investigation are here given:

The observations from which the following conclusions are drawn have been made in different parts of the German Empire for the past ten years.

1. Statistics show that in Schleswig-Holstein, Baden, and Hesse, in thickly settled districts, a constant increase of damage from lightning does not appear to be proven any more than a decrease.

2. The yearly as well as the daily periodicity of lightning flashes corresponds very closely with the storm frequency. One interesting fact, previously noted, is that on the west coast of Schleswig-Holstein the greatest number of lightning flashes occur in the first hours after midnight.

3. In Schleswig-Holstein, in the ten years from 1874 to 1883, of all the buildings struck by lightning, of those with "hard" roofing, 9 per cent. caught fire, 91 per cent. did not; with "soft" roofing, 68 per cent. caught fire, 32 per cent. did not; so that buildings with "soft" roofing when struck by lightning catch fire from seven to eight times as often as those with "hard" roofing. Besides this consideration of the nature of the roof, the nature of the building is of importance. Averaging for a year of a million instances:

Ordinary buildings (with "hard" roofing, 163, with "soft" roofing, 386) 290 are struck; churches, 6,277 are struck; wind-mills, 8,524 are struck; manufactories, chimneys, etc., 306 are struck.

In Schleswig-Holstein, the risk from lightning to churches and bell-towers is thirty-nine times, and in the case of wind-mills fifty-two times, greater than in the case of ordinary buildings with hard roofs.

4. In the case of Schleswig-Holstein the marsh lands from Husum to Steinberg are often struck while the country around the fiords of the east coast is entirely protected. The coefficient representing the number of buildings struck of a million is generally from four hundred to five hundred and forty; but here falls to one hundred and sixty or one hundred and seventy, *i. e.*, about one-third. The great danger in the case of flat and moist lands comes from the fact that the farm premises are the most prominent features of the landscape, and the ground, besides, is quite moist.

5. The risk of danger from lightning decreases with increase of number of houses contained in any given district. In Prussia the risk in the country is five times greater than in the city districts. In Berlin the number of fires caused by lightning averages only 0.2 to 0.3 of one per cent. For an ordinary dwelling house, which stands among others, not particularly high, the erection of a lightning-rod is not needed.

6. In the Grand Duchy of Baden differences in the distribution of lightning strokes are found. In Heidleberg of a million, twenty-four buildings are struck, while in Waldshuter the rate is two hundred and sixty-five.

7. In the northern half of Baden and the neighboring half of Hesse the number of buildings struck between 1868 and 1883 shows a decrease.

8. In Hesse the parts protected best are regions along the Rhine, where the encircling hills and mountain sides are interposed to protect them. But the danger is increased where, as in the case of Rhine Hesse, the country above is wooded.

9. The causes of variations in the number of buildings struck are to be sought in local causes and not in extra-territorial happenings. The supposed relation between frequency of lightning strokes and sun spots appears to have no foundation.

10. Averaging for fifteen years, of a million of people, the number killed by lightning is, in Prussia, 4.4; Baden, 3.8; France, 3.1, and Sweden, 3.0.

11. The geological features of the ground, particularly the water capacity, have a marked influence upon the number of lightning strokes. If we call a chalk-bed, 1; then we have for marl, 2; for clay, 7; for sand, 9, and for loam, 22. These conditions have much to do with the frequency of lightning strokes in the flat lands of northern Germany, as compared with southern Germany and Austria.

12. Differences in space and distribution of lightning strokes are due to four causes; two of a physical and two of a social nature. The first, the unequal frequency of storms, and the difference in the geological character of the earth; the latter, the changing and the improved construction of buildings.

13. Of all trees, the oak was most frequently and the beech least frequently struck. If we let 1 equal the beech, then pines are 15, oaks 54, and other trees, 40.

14. Most frequently the trees struck were standing in the clear, or on the edge of forests, and averaging from sixteen to twenty metres high.

15. The trunk is struck about three times as often as boughs, and generally the stroke seems to travel toward the ground. Only in three of one hundred cases did it jump to other trees.

the mean of the eighteen preceding years. The highest temperature was 105° on August 16th; the lowest was 18° below zero on the 9th of January, giving a range of 123°. Mean, at 7 a. m., 47°.13; at 2 p. m., 62°.16; at 9 p. m., 51°.28.

Mean temperature of the winter months, 23°.33, which is 5°.88 below the average winter temperature; of the spring, 54°.57, which is 0°.96 above the average; of the summer, 76°.80, which is 0°.96 above the average; of the autumn, 57°.17, which is 3°.39 above the average.

The warmest month of the year was July, with mean temperature 79°.54; the warmest week was August 11th to 17th, mean 86°.93; the warmest day was August 16th, mean 90°.62. The mercury reached or exceeded 90° on fifty-three days, thirteen more than the average number, viz.: two in May, three in June, twenty-one in July, eighteen in August, and nine in September. There were five days on which the temperature exceeded 100°—one in July and four in August.

The coldest month was January, with mean temperature 14°.32; the coldest week was January 6th to 12th, mean temperature 0°.61 below zero; the coldest day was January 8th, mean 12°.75 below zero. The mercury fell below zero on sixteen days, of which ten were in January, three in February, and three in December.

The last hoar frost of spring was on April 27th; the first hoar frost of autumn was on October 1st; giving an interval of one hundred and fifty-five days, or over five months, entirely without frost. This is precisely the average interval.

The last severe frost of spring was on April 5th; the first severe frost of autumn was on the 27th of October; giving an interval of two hundred and three days, or nearly seven months, without severe frost. The average interval is one hundred and ninety-eight days. No frosts during spring and autumn caused damage to crops of grain and fruit, but the low temperatures of January were universally destructive to peach buds.

Rain.—The entire rainfall, including melted snow, was 24.25 inches, which is 11.02 inches below the annual average. Either rain or snow, or both, in measurable quantities, fell on one hundred and three days—one less than the average. On fifteen other days rain or snow fell in quantity too small for measurement.

The number of thunder-showers was twenty-eight. There was but one light hail storm during the year.

The drought which prevailed during July, August, and September, was the only serious drought in Kansas since 1874. From June 26th to July 24th, an interval of twenty-seven days, there was entire absence of rain. From the same date to September 16th, a period of eighty-one days, the rainfall was but 2.85 inches. In 1874 the drought extended from June 14th to September 3d, an interval of eighty days, during which the rainfall was only 2.19 inches. Thus the drought of 1886 was one day longer than that of 1874, but the latter began nearly two weeks earlier in the season and was, therefore, more disastrous in its effects.

FREQUENCY OF LIGHTNING STROKES.

[From Beiträge zur Statistick der Blitzschläge in Deutchland, von Dr. Hellmann, Berlin, 1886; Zeit. d. König. Preuss. Stat. Bureau, 1886. Translated by ALEX. MCADIE, Sergeant, Signal Corps, U. S. Army.]

A summary of the results of the investigation on the frequency of lightning strokes in Germany appears as one of the reports of the Royal Prussian Bureau of Statistics. As it deals directly with risk of damage to buildings from lightning the main conclusions of the investigation are here given:

The observations from which the following conclusions are drawn have been made in different parts of the German Empire for the past ten years.

1. Statistics show that in Schleswig-Holstein, Baden, and Hesse, in thickly settled districts, a constant increase of damage from lightning does not appear to be proven any more than a decrease.

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